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ORIGINAL ARTICLE

Social Economic Benefits of an Underground Heritage: Measuring Willingness to Pay for Karst Caves in Italy

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Abstract
Karst caves are widespread in Europe, especially in the Mediterranean area. Besides their purely environmental functions, they often are important tourist destinations and contribute to the so-called identity amenities or landscape beauties of a territory. In spite of their interest and tourism potential, economists have paid little attention to karst caves and their economic value. In this paper, the contingent valuation method (CVM) was applied to investigate tourists' preferences and estimate the monetary value attributed to karst caves, and in particular to the Pradis Caves, Friuli Venezia Giulia region (Italy). 540 visitors of the area took part in a face-to-face contingent valuation survey. Mean willingness-to-pay was equal to € 5.37. When scaled up to the population, gross social benefit was estimated in about € 23 K/year. Findings suggest that the karst cave value could have a significant impact on the social welfare gains or losses, and inform the karst cave-use management debate concerning the trade-offs of developing tourism activities. The estimated values allow institutional decision makers to identify the volume of financial resources to be put into play for interventions aimed at protection and conservation of this environmental asset.

Keywords Contingent valuation · Karst caves · Tourist enhancement · Sustainable development

Introduction

The development of natural heritage–based tourism is a well-known phenomenon (UNWTO 2017). Its widespread popularity (Hall 2019; UNWTO 2017) is built on two different — albeit connected — aspects: firstly, the need to guarantee a certain level of protection of the landscape-environmental context and secondly, the opportunity to exploit positive impacts of tourism activities on natural capital (Antić et al 2022; Milenković 2021; Ballesteros et al 2019; Santangelo et al. 2015). In fact, on the one hand, revenues from tourism activities often generate a proportion of the budget to support maintenance and conservation of natural resources; moreover, local development benefits from economic relationships with tourism (e.g. occupation, businesses): in many territories, and especially in certain periods of the year (i.e. high season), the induced activities that revolve around touristic natural resources certainly have positive socio-economic impacts. On the other hand, overtourism may decrease ecosystems space to recover, reduce environmental quality and conservation, etc., which are fundamental conditions to attract tourists.

Karst caves are multifunctional environmental structures characterized by the presence of basic natural resources, both renewable, such as water, and non-renewable, as in the case of minerals, which provide a wide set of functions and ecosystem services, i.e., support and containment system for biodiversity (Iliopoulou-Georgudaki and Skuras 1995); ability to assimilate any negative externality (Angulo et al. 2013; Harley et al. 2011; Williams 2008); provision of cultural ecosystem services (e.g. landscaping and pleasant resources); and building of special identity, capable of qualifying the territory and promoting human well-being (United Nations 2021; Algeo 2013; Angulo et al. 2013; Williams 2008).

According to the 2030 Agenda for Sustainable Development Goals (SDGs), tourism plays a crucial role in enabling

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the achievement of sustainable development, involving social, economic, environmental, cultural, and governance dimensions, including ethical and political concerns and promoting dialogue, conflict, and negotiation among a range of actors (United Nations 2021; Bramwell et al. 2017). Issues involved in managing these different functions include social conflicts between stakeholders, with respect to both environmental and socio-economic impacts. The need to balance touristic exploitation and conservation of environmental quality has fostered the interest in karst caves as touristic underground heritage sites able to support economic development (Antić et al 2022; Ballesteros et al 2019; Gordon, 2018; Tičar et al. 2018; Brinkman and Garren 2011). Cigna and Forti (2013) conservatively estimated the existence of at least 500 show caves worldwide each largely exceeding 50,000 visitors/year, and all together generating a gross revenue of 1.25 billion/year. While these rough estimations would surely benefit from revision and updates, no other study currently provides more precise figures. Nevertheless, this appraisal suggests at once the economic potential of tourist exploitation of show caves as well as the need for adequate protection and management to limit potential negative effects of mass tourism on their fragile and vulnerable environment. In the attempt to manage and balance both environmental and socio-economic aspects, for instance, the International Show Caves Association (ISCA), the Union Internationale de Spéléologie (UIS), and the International Union for Conservation of Nature and Natural Resources (IUCN) cooperated to create UIS Management Guidelines for Show Caves, which issues indications and recommendations. Similarly, the Italian Tourist Caves association was established in 1994 to guarantee environmental protection, encourage the exchange of experiences in managing caves, promote interest in the underground heritage, and enhance scientific dissemination.

The fundamental issue of karst cave scarcity and the objective of their sustainable exploitation assign to economic analysis a key role in identifying strategies aimed at mitigating a number of potential negative consequences of this process. Following the conventional marketing approach (Kotler 1992), punctual analysis of tourism demand sets the grounds for any project of enhancement/planning of interventions. In the case of cave tourism, such an analysis becomes fundamental for two reasons: firstly, it represents a substantial element for estimating the economic value of the environmental heritage; secondly, it allows to determine the current and potential impact of fruition on the cave itself and/or on the surrounding territory.

The estimation of the economic value of caves is essential to make the conservation work associated with environmental monitoring more effective (De Waele 2007), as it provides the opportunity to compare costs and benefits in managing such heritage. Economic monetary valuation is a key step in the path towards sustainable development aimed at using the market to protect the environment (Turner et al. 1993). As stated above, this approach is necessary to minimize the trade-off between "forced conservation" and "enhancement" of environmental assets by encouraging sustainable use (Coccossis and Nijkamp 1995; Bottrill and Pearce 1995). Examinations of social benefits that include monetary value of karst caves are needed to fulfill social demand to scale up tourism activities while simultaneously minimizing social costs and environmental impacts (Torres-Ortega et al. 2018).

Scientific research on karst caves has long favored the environmental and archeological perspectives, while the analysis of socio-economic, tourism, and management aspects is still limited (Antić et al., 2022, 2020; Ballesteros et al 2019; Cigna, 2016; Dans and González 2018; Hoblea et al 2014; Garofano and Govoni, 2012; Cigna and Burri, 2000), as is the literature on net social benefits of karst caves.

Given the importance of this form of natural heritage, the estimation of its monetary value based on tourists' interest can be a worthy decision tool. Consequently, we decided to carry out a survey to collect data in order to elicit the economic value of karst caves. Our empirical analysis centered upon a specific case study in Italy. The novelty of this study is threefold. Firstly, we investigated a number of factors that influence tourists' behavior in visiting karst caves. Secondly, we provide specific insights into the management of tourism activities in these heritage sites and their benefits. Thirdly, the results and indications obtained from this exploratory study could be extended and adapted to other similar heritage sites where similar conservation and tourism practices policies are in place to protect caves.

The paper is structured as follows: after the introduction (paragraph 1) and the research aim (paragraph 2), the methodology used in the monetary evaluation of the Pradis karst caves is presented (paragraph 3); the results obtained from the application of the methodology are described in paragraphs 4; paragraph 5 provides a general discussion of the findings, together with further reflections substantially linked to the principles of sustainable development, as well as the limitations of our study and potential for further research.

Research Aim

With respect to the state of the art, this contribution intends to propose an advancement of knowledge by aiming at estimating the economic-monetary value of karst caves as a complex asset, able to provide multiple ecosystem services, and, in addition to the conservation of the cultural-environmental assets, supporting its enhancement in a strategic, sustainable territorial development perspective. The economic

monetary evaluation of karst cave represents a fundamental aspect capable of producing know-how by looking at the poor knowledge of decision makers about benefits when managing this heritage.

This study deals with the use of monetary evaluation to determine the economic value of karst caves in an Italian region, i.e., Friuli Venezia Giulia, where the system of the Pradis Caves is located. This system is known as an imposing monumental heritage (Nannini et al. 2022; Duches et al. 2020). Since decisions about heritage conservation can be contentious (Wright and Eppink 2016), this study aims to reach better insights into the economic benefits derived from preservation through monetary valuation. Since on the one hand this heritage site is viewed as having characteristics of a capital asset, but on the other hand, its economics remains little understood, monetary evaluation can inform decision makers and help choices about Pradis Caves conservation.

Material and Methods

The Pradis Caves

The Pradis Caves are located in the karst area of the upper course of the Cosa River, in the Carnic Prealps, in the North-Eastern Italy (Fig. 1). The area is made up of several, large, and articulated cavities, from the gorge created by the Cosa River and the "cave-sinkholes." This phenomenon, commonly referred to as karst, is determined primarily by a chemical mechanism that takes the name from the dissolving calcium carbonate, but also by an intense erosive action.

The beauty of these places was already grasped in the early 1900s foreshadowing their future enhancement, which was implemented in the 1960s, when the cavity that houses the "Virgin Mary Cave" was inaugurated. The Pradis Caves are also known as an important archeological site frequented since the Middle Paleolithic (90,000–40,000 years ago).

The opportunity to develop both tourism and research activities has been decided since 2005, when a cave was conceived as a laboratory with daily guided tours, archeology activities, and thematic seminars. The positive response of the public and the possibility of using the suggestive sinkhole in front of the cave increase the desire to continue these activities. A number of active protection activities of the underground environment were implemented when the local speleological group held courses on approach to caving. The Ecomuseum Lis Aganis-Regional Ecomuseum of the Friulian Dolomites, in collaboration with the Municipality of Clauzetto and other local institutions, promoted further projects to improve the knowledge of the area.

Since 2010, tourism activities have been managed by the Municipality of Clauzetto in collaboration with a number of authorized operators who collect payments for the entrance ticket. The caves are opened to visitors from Easter Monday to September, giving groups the opportunity to book tours outside the official opening period. The visit includes the opportunity to receive historical and scientific explanation provided by specialized cultural operators. Table 1 describes the number of visits per year and per type of ticket. As it can be observed, a positive trend emerged during the period considered (2010–2021). About 64% of visitors pay a full ticket to visit caves, while 19% can visit by paying a reduced ticket.

The Contingent Valuation Method

The karst caves are not generally traded in the market and are consequently referred to as non-market goods. The estimation of the demand function of environmental resources is

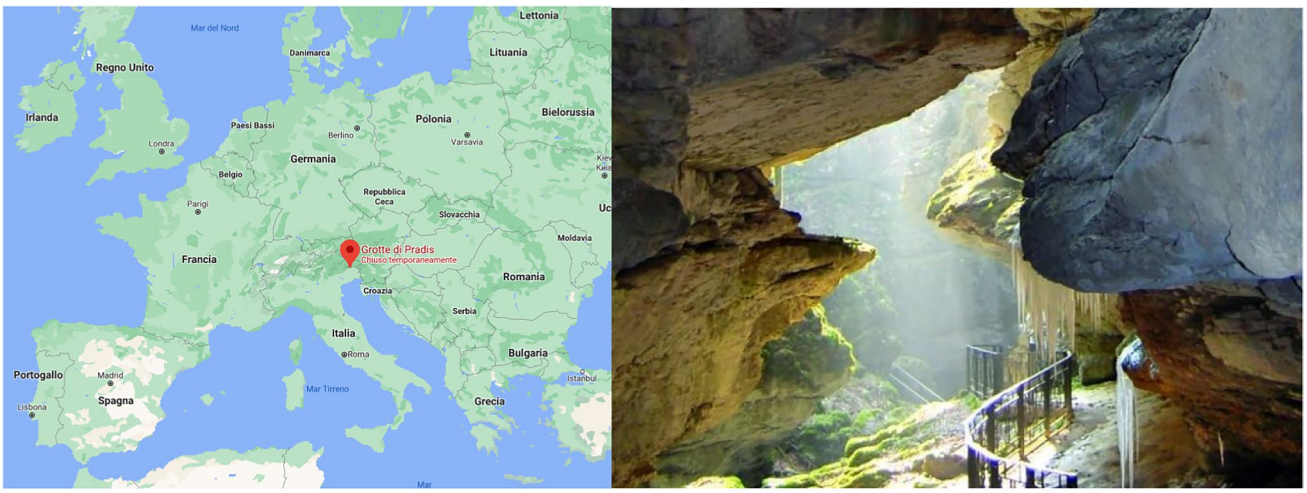

Fig. 1 Pradis karst cave in Friuli Venezia Giulia Region (Italy). Source: Google Maps; pordenonewithlove.it

Table 1 Visits per year and type of entrance (2010–2021)

Type of entrance fee/year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Mean	%
Full ticket	5850	6429	5668	5949	n.a	n.a	7248	8205	12,086	11,208	15,299	14,710	9011	64
Reduced ticket	2268	1844	2303	2490	n.a	n.a	2218	2608	3246	3190	3663	3628	2722	19
Free ticket	900	748	809	660	n.a	n.a	1313	1755	1567	1366	1951	1909	1298	11
Guided tours	23	59	72	21	n.a	n.a	803	936	807	884	72	202	388	3
Total	9041	9080	8852	9120	9006	10,686	14,960	18,010	17,706	16,648	20,985	20,449	14,172	100

n.a. data not available.

not an easy task. However, according to the microeconomic theory, information about both the lower area of the demand function (i.e., benefits) and the demand function itself are useful.

Scholars have identified various techniques capable of attributing a monetary value to goods that are "priceless" because the market typically fails in resource allocation (Bishop and Heberlein 1979; Bishop and Romano 1998). Among others, the "direct" methodologies, which are based on the preferences expressed by consumers, have found widespread application in the substantial international and national scientific literature (Garrod and Willis 1999). In particular, we refer to the CVM (Mitchel and Carson 1989), which is used to elicit respondents' willingness to pay (WTP) (Carson and Hanemann, 2005). CVM evaluates the preferences of the consumer through the establishment of a hypothetical market in which the respondent is called to directly express the willingness to pay (WTP) in order to continue to take advantage of a certain environmental resource, or allow its conservation. The WTP represents the price or "the maximum synthetic and monetary expression" of users' preferences (Signorello 1986, p. 32). CVM is a widely used and practical approach for quantifying the use (i.e. present worth of a resource) and non-use values of environmental resources (e.g. the benefits to future generations) and capturing their total economic value (TEV) (Hanemann 1994). For this reason, CVM represents the most suitable technique to express the TEV of an environmental resource. Moreover, according to Tuan and Navrud (2007), CVM is suited to estimating the economic benefits of preserving a heritage.

The CVM relies on a questionnaire to directly ask people WTP for the abovementioned values, hence creating a hypothetical market context in which the non-market good of interest can be described and recognized as traded (Mitchell and Carson 1989). Interviewers are assumed to state the CVM question according to the value they place on the proposed scenario. The aim is to estimate the net change in the income of a respondent which is equivalent to, or compensates for changes in the quality or quantity of the non-market good in question.

According to Noonan (2003) and Throsby (2003), CVM has a number of limits: it provides an incomplete view of the non-market value of a good; in addition, most results appear sensible on the surface, while poor methods plague a number of studies; moreover, the distribution of WTP values can be influenced by survey design, familiarity with the good/service, and whether the context scenario involves more abstract resources. Furthermore, Noonan (2003) stated information bias continues to pose a critical obstacle in CVM applications.

Despite a number of criticisms, because of its high flexibility and easiness to understand, CVM is considered as one of most widely used non-market valuation techniques to estimate economic values for non-market goods (Haab et al.. 2020; Tuan and Navrud 2007). Alternatively, the choice experiment (CE) method proves to be one of the most powerful tools to estimate economic values of environmental goods; however, it values attributes of the good rather than the good as a whole (Lancaster 1966; Louviere et al.. 2000), and requires respondents to have both adequate information about the good and a particular cognitive ability level. In comparison with CE, CVM is able to better fit the aim of our study, since it directly elicits WTP from respondents and estimate it for the whole good; it therefore better fits the need of our research to estimate the total economic values obtained of karst cave.

A number of studies used CVM to estimate economic benefits of caves. For example, Khodaverdizadeh et al. (2011) collected among visitors 160 questionnaires to estimate both average WTP (about $ 0.10) and annual ecotourism value of Sahoolan Mahabad cave ($ 20,116.38). Huth and Morgan (2011) found divers' median WTP for cave diving at The Edward Ball Wakulla Springs State Park in Florida (between $ 52 and $ 83 per dive). To estimate visitors' WTP for the Yanchep Caves Recovery Project, Tapsuwan et al. (2010) used CVM and identified the median WTP for cave and park entry fees (between AU$10.20 and AU$16.40). Aynon et al (2015) applied the Contingent Valuation Method to estimate how much people are willing to pay for the preservation of the Tabon Caves Complex in Quezon, Palawan Province: according to the results, the

existence value of the site, as perceived by the people of Quezon, is equal to $ 19,412.22.

More recently, Susilowati et al. (2018) estimated tourists' WTP for the Tourism Attraction of Jatijajar Cave in Kebumen Regency using CVM approach. Results showed that the average tourists' WTP is about $ 0.0012, while the total value of WTP is about $ 373,672. Furthermore, Bashit et al. (2019) followed the CVM approach to identify the TEV of Kreo Cave (Indonesia), estimated in Rp. 552,610,924,100 ($ 38,395,982.15 in 2017). Khodaverdizadeh et al. (2011) estimated that visitors are willing to pay an average WTP of 4235 Rials ($ 0.41 in 2011) for the use of the caves and a total annual WTP of 847,000,000 Rials ($ 81,802.88 in 2011).

Perriam et al. (2008) analyzed how much visitors are willing to pay to prevent further drops in the water level in the caves. The survey estimated that the median WTP for park entry was $13.85, which represents an increase of $3.67 on the current adult entry fee. These increases would raise annual revenue by $184,800 per year for park entry, and $61,056 per year for cave entry.

In this study, we decided to collect data among tourists to estimate the monetary value of the karst cave. Tourists of the study areas were asked their preferences for hypothesized scenarios using CVM by asking their WTP to support sustainable management of caves. Their responses were then used to calculate the total social benefits.

The execution of the survey adhered at its best to the guidelines pointed out in literature (McFadden and Train 2017). According to Kanninen (1993) and Haab and McConnell's (2002) recommendations, previous data collection, pilot surveys, and focus groups were conducted in order to assess and eventually modify the questionnaires. In addition, to prevent bias due to the influence of others' replies, all respondents were individually interviewed and their answers kept confidential.

In our study, respondents' maximum WTP was estimated as the amount that makes them indifferent between the *status quo* (or the initial level, i.e., the existing economic activity level of the karst caves), q_0 with an income y, and the final level/increment (i.e., the improved sustainable management), q_1 with an income y-WTP, according to the following indirect utility function:

$$V(p, q_0, y) = V(p, q_1, y - WTP) \tag{1}$$

Respondents' WTP for the improved situation can be defined by using the following expenditure function:

$$WTP = e(p, q_0, U_0) - e(p, q_1, U_0) \tag{2}$$

where p is a vector of prices for market goods, and U_0 is the reference utility level created by the indirect utility function $V(p, q_0, y)$. The individuals are asked to spend more, remaining at utility level U_0, to be sure that the condition of the karst caves is improved. Substituting the indirect utility function in the expenditure function yields the compensating surplus function, where the WTP is a function of observable variables:

$$WTP = y - e(p, q_1, V(p, q_1, y)) \tag{3}$$

According to Alberini and Kahn (2006), WTP is positive because the needed expenditures to reach the utility level with the increment are lower than income.

The Experimental Design

Face-to-face interview surveys were conducted from July 2013 to July 2014. The survey was carried out among tourists to estimate the benefits perceived by visitors of the caves and assess the importance of their conservation.

The questionnaires were distributed at the infopoint. Since the descent to the ravine counts 207 steps, almost all visitors, at the end of the excursion, are forced to stop at the benches before tackling the loop path above the gorge that takes them back to the parking. It was during this moment that the interviews took place.

The survey involved 540 visitors chosen in relation to their gender, age, and visiting time. To better identify the sample, the daily visit registers kept by the Municipality of Clauzetto, that manages the tourism activities, were analyzed and thus used to better define the characteristics of visitors according to the type of ticket, taking into account the implemented price discrimination referred to the "third type" (Marangon and Tempesta 1998; Varian 2012). By analyzing the monthly and daily flows of visitors, a stratified sampling plan was utilized, assuming that demand differs during the year according to the emerging well-defined trend. It was possible to point out tourism seasonality, since we observed a rise in the number of visitors from June to August, which totaled an average of 46.4% of total visits, and then a decline of visitor flows during September and October.

Considering that visitors often came in groups, it was possible to obtain information relating to 2113 people (i.e., 23.4% of the average number of visits per year in the period 2010–2013; 36.9% of those recorded in the survey year). However, the percentage of the sample on the entire observed population is 5.24%, while referring to the visits carried out by the interviewees the percentage rises to 8.19%.

The WTP Elicitation

A focus group discussion was organized to choose a payment vehicle for respondents and define the questionnaire,

which was divided into four sections. In the first part, a number of answers aimed to collect data about the interview and the trip (date, time, weather, type of entrance fee, etc.) were presented and karst cave tourism activities were described with background information related to the examined case study. In the second section, the respondents were asked to give information about their recreational experience, including data needed to eventually carry out the travel cost method. In the third section, tourists were proposed a hypothetical increase of cave tourism activities to apply the CVM. They were asked to express the amount of money they would be willing to pay for a price increase of the admission ticket in exchange for an expansion of the tourism offer on the Pradis caves. To avoid bias created when respondents do not have enough knowledge about the research topic, detailed background information related with our examined karst cave were provided to facilitate the respondents to present genuine answers.

In the description of the scenario, particular attention was paid to understand the respondents' level of awareness and knowledge of the asset, to be sure they took into consideration the changes in their well-being that could occur following the occurrence of the described situation. The description of the scenario was phrased so as to present a readily understood, clearcut context. Then, the respondents were asked to answer the following question: "Please give the maximum amount of the entrance fee (€/trip) you are willing to pay to increase the offer of tourism activities without decreasing the number of your annual trips."

The first question had the function of establishing whether or not people were willing to pay an entrance ticket higher than the current one, i.e., € 3.50 for full and € 2.00 for reduced tickets.

The open-ended estimation was employed to elicit WTP, giving the respondents the opportunity to answer by stating the maximum amount they are willing to pay. According to Bateman et al. (2002), the open-ended CVM has been widely used in stated preferences studies mainly because of its simplicity. Compared with the dichotomous choice eliciting method, the open-ended method was considered suitable for this survey since it is easy to operate and conduct data analysis; the maximum WTP is directly identified and guarantees the absence of anchoring effects of the bid. Furthermore, using other CVMs requires respondents to spend more time and efforts on the survey. Nonetheless, considering that open-ended elicitation can lead to protest answers, a follow-up question was added (i.e. "If you report a zero, please give the reasons") to identify these answers and better understand the reasons for them. In addition, according to Kotchen and Reiling (1999) and Mitchell and Carson (1989), an income constraint reminder was added to make the interviewees aware of the opportunity costs they faced.

According to Riera et al.. (2012), once an initial version of the questionnaire was completed, it was pre-tested on a sub-sample of the overall survey population to ensure that the questionnaire was as comprehensible as possible.

Results

The Socio-demographic Characteristics of Respondents and the Recreational Experience

The majority of the interviewees were male (53.9%) and came from nearby municipalities (56.2%), while their average age was 43 years. More than half respondents (54.6%) had at least completed high school license, and most of them (63.5%) were wage-earners. The majority (56.0%) declared a net annual family income in the range 10–30 thousand euros. Overall characteristics of the sample are comparable to previous similar studies (Perriam et al., 2008; Tapsuwan et al. 2010).

The profile of the interviewees was also outlined referring to their attitude towards the environmental topic. Sensitivity to ecological issues was examined by asking their opinion about the conservation of the environment: most answers were distributed between "very much" (82.5%) and "a lot" (16.2%). Only 5.4% of the interviewees declared to be members of an environmentalist association.

The recreational behavior was then detected by asking how many trips were made on average each year in mountains, hills, countryside, and sea areas. Pradis Caves are located at 530 m above sea level and are considered a hill area, but surprisingly, the declared average number of visits in this territorial context is the smallest (i.e., 4 annual trips). The highest number of trips was to the sea (10 trips per year), followed by mountain trips (9 annual trips) and 8 trips/year in the countryside. The scarce declared presence in the analyzed territory suggests that tourist presence is mainly random and at least occasional.

To reach the Pradis caves, visitors traveled distances between 4 and 270 km, and the average time taken for the journey was 61 min, almost all (87.0%) traveled by car. Only 63, equal to 11.7% of the total sample, used the motorway system, with a maximum toll payment of € 85. Considering only the car, it was calculated that on average 4 people traveled in each car, including the driver.

The trips carried out during the day of the visit to the caves last circa 6 h. This short duration is explained in both the shortness of the path and of the visit, which takes about an hour. 152 people, equal to 28.2%, declared that they had visited other places during the same day, while for the remaining 71.9%, the trip to the caves was exclusive.

As regard the time spent in the Pradis hamlet, the average was 6 h, without taking into consideration the time for the

visit, waiting times before entering the cave and eventual pause after the climb to the exit, meaning that most people were staying in the village for a maximum of half a day.

The shortness of the total duration of the trip and the fact that in most cases, it was limited to the cave visit explain why only 12.8% of the interviewees incurred in expenses for catering in public places and 26.1% had brought a packed lunch. Other expenses incurred during the day and identified in the survey are those for purchases of typical local food products, for the most part cheese and derivatives of the local dairy.

Similar to the results from Perriam et al. (2008), respondents were mainly infrequent visitors, as 64.8% of respondents stated that was the first visit to the caves in the last 5 years, while 21.3% had already been once and the remaining 13.9% affirmed they had made more than one visit (with a maximum value of 7). Taking these answers into account, we can estimate that, with 540 respondents, information related to a total of 844 visits in the 5-year period preceding the interview.

Almost half (45.1%) of respondents affirmed they learned of the existence of Pradis caves through family members, colleagues, internet, Pradis mineral water, at school and stands promoting local tourism: 39.3% through friends, 8.9% came into possession of a brochure, 3.8% through newspapers, and 2.3% through billboards. Therefore, in the case of this tourist-recreational experience, it is noted that word of mouth and advice received from friends who had already visited the caves are the most effective means to stimulate a visit to the karst area. With reference to the motivating factor of the visit, the so-called "naturalistic reasons" clearly prevail as indicated by over 70.0% of the interviewees, followed by the willingness to have a picnic in the mountains (15.6%).

As regard the opinion of the interviewees on the tourist visit carried out inside the caves, an indication of strong appreciation was detected, given that (excluding the only 3 non-respondents) 46.2% declared their maximum satisfaction, followed by 45.4% who chose the answer "a lot"; no one rated the visit as "little" or "no" satisfactory. The same scale was used in another question to find out the interest of visitors for the projects to expand the underground tourist offer on Pradis caves: strong and favorable was the indication of people for the opportunity to admire new cavities, in fact 84.5% answered "very much" or "a lot."

The Tourists' Willingness to Pay

In order to identify the WTP, which is a crucial element in estimating the recreational value (Mitchel and Carson 1989), in the case study of Pradis caves we opted for the "open-ended" CVM method taking into account the aim of our study. According to Zawojska et al. (2017), this approach seems to be less noisy and estimated on average lower WTP. In addition, Vossler and Holladay (2016) identified theory-based conditions under which an open-ended value elicitation format is incentive compatible, in the sense of providing respondents with incentives to reveal their preferences truthfully. Our research met all these conditions in our field open-ended survey. Moreover, the simplicity of this method and the fact that no approach can be considered exempt from criticisms were considered before deciding (Marangon and Tempesta 1998; Mitchel and Carson 1989).

Descriptive statistical analysis was utilized to analyze WTP in general and according to the type of entrance fee paid by visitors (Tables 2 and 3, respectively). The WTP response summary statistics are shown in Table 2. Overall, he answers showed values ranging from € 0.00 (1 case only) to € 15.00, with the modal amount represented by € 5.00. Considering the levels of skewness (symmetry) and kurtosis (peakedness), it is possible to identify a positively skewed response and leptokurtic distribution. The shape of the distribution suggests that the majority of respondents declared WTP values lower than the mean value (€ 5.37), as confirmed by the median (the observation which separates lower and higher halves of the population) and the mode (the most frequently occurring value), both equal to € 5.00. Consequently, the mean WTP is inflated by fewer higher values; that is, a smaller share of visitors would be ready to pay higher entrance fees in exchange for improved tourist services.

The descriptive statistics provide helpful information on the frequency of the WTP-values. In detail, 0.2% of the sample suggested WTP equal to €0, while 4.1% agreed with WTP from €0.50 to 3.00, 77.4% accepted a WTP from €3.01 to 6.00, 15.9% mentioned WTP in the range from €6.01 to 10.00, and 0.4% was willing to pay more than €10.00 (Table 3).

Table 2 WTP descriptive statistics

Descriptive statistic	
Mean	5.37
Standard error	0.08
Median	5
Mode	5
Standard deviation	1.71
Sample variance	2.91
Kurtosis	3.72
Skewness	1.41
Range	15
Minimum	0
Maximum	15
Sum	2,728.5
Count	508
Confidence level (95.0%)	0.15

Table 3 WTP and type of entrance fee

WTP (€)	Free entrance fee	Reduced entrance fee (€2.00)	Entrance fee (€3.50)	Total	% Total	% Replies
0.00	1			1	0.2	0.2
0.50			1	1	0.2	0.2
2.00			8	8	1.5	1.6
2.50			2	2	0.4	0.4
3.00	1	5	14	20	3.7	3.9
3.50	1	2	17	20	3.7	3.9
4.00	1	2	30	33	6.1	6.5
4.50		1	10	11	2.0	2.2
5.00	3	11	271	285	52.8	56.0
5.50			1	1	0.2	0.2
6.00	1	1	42	44	8.1	8.6
7.00	1		31	32	5.9	6.3
8.00	1	1	15	17	3.1	3.3
10.00	1		31	32	5.9	6.3
10.50			1	1	0.2	0.2
15.00			1	1	0.2	0.2
No reply		2	29	31	5.7	100.0
Total	11	25	504	540	100.0	

Among the 509 who indicated an amount, 18 (3.5%) declared they wanted to maintain the level of the current ticket. In addition, 25 respondents (4.9%) could be defined as critical on the visit experience compared to its cost, since they expressed a WTP lower than the paid entrance fee (having all of them paid the full ticket). Furthermore, it is worthwhile noting the relation between WTP and type of entrance fee. The respondents who were willing to pay higher amounts did not always pay a fee, while those that paid a reduced entrance fee declared a lower WTP.

The estimated average WTP is equal to € 5.37 per trip if all those who have expressed a value, even lower than that actually paid, are included. The estimated WTP rises slightly to € 5.52 per trip if the 25 cases previously defined as "critical" are excluded, and to € 5.60./trip if the 18 respondents who stated they did not wish to change the ticket are also left out (Table 4). For all the abovementioned three estimated WTPs, the median value is € 5.00 per trip.

By dividing the interviewees in relation to the ticket paid for the visit, it is possible to identify 11 subjects who paid for a reduced ticket and indicated an average WTP (€ 4.50/trip), which remains constant in all abovementioned approaches, while the interviewees who paid a full ticket declared an average WTP from € 5.42 to € 5.66. Finally, the range of the average WTP for the 23 respondents who benefited from free tickets is equal to € 5.14–€ 5.65.

The questionnaire also requested interviewees to indicate the level of entrance fee which would discourage their visit to Pradis caves, i.e., the exit price. 464 respondents (85.9%) would not be willing to pay a ticket equal to € 11.07. This value rises to € 11.40 among the interviewed (10 cases) that enter for free. Lastly, the lowest exit price (€ 9.45) was expressed among those who paid a reduced ticket (20 cases).

Table 4 Respondents and mean WTP by type of entrance fee

Type of entrance fee	Total number	Only WTP ≥ 0 (number)	Only WTP > 0 (number)
Respondents	509	484	466
	WTP (€)	**WTP (€)**	**WTP (€)**
Full ticket	5.42	5.58	5.66
Reduced ticket	4.50	4.50	4.50
Free ticket	5.14	5.14	5.65
Mean	5.37	5.52	5.60

To identify the main variables that have mainly influenced the generic WTP, we carried out a logistic regression, in detail:

$$LogOdds = 1.037 + 0.234 \times freq + 0.23 \times income + 0.155 \times occup - 0.033 \times gender + 0.522 \times study - 0.019 \times year$$

where "freq" is the variable describing the number of trips to Pradis caves, "income" is the respondents' stated income, "occup" is the variable describing the professional occupation of interviewees, "gender" is the variable for the respondents' gender, and "study" describes the educational level. A backward stepwise selection based on likelihood

ratio tests for the coefficients was used to retain only statistically significant variables. Table 5 reports the main results of the logistic regression.

The results allowed us to identify the role of the educational level in determining the willingness to support the proposed project, which is consistent with the findings of Tapsuwan et al. (2010). In addition to this, income and the occupational position of respondents are able to significantly explain the availability to contribute to enhance tourism activities in the area of Pradis caves.

Analyzing the above mentioned WTP estimation, the net benefit per trip per respondent is around € 2.16, when paying a full ticket of € 3.50 (66.0% of visitors), and € 2.50 for those who pay a reduced ticket of € 2.00 (25.0% of visitors), while it can be estimated at € 5.65 for free entrance fee (9.0% of visitors) (Table 6).

The estimates are useful to quantify the Gross Social Benefit (Johansson 1987) produced by caves (i.e. their economic value). According to the observations carried out in the period 2010–2014, we assumed that visit trend stands at 9 thousand total units, of which about 6 thousand for full entrance fee, about 2.25 thousand for the reduced fee, and around 800 units for the free ticket. With this data, the gross social benefits can be estimated at € 23 K per year. The amount would rise to over € 38 K a year if visits would reach the figures recorded in 2016 with the same distribution among types of tickets.

Table 5 Logistic regression results

Variable	Coefficient	s.e	z-Statistic	P-value
Freq	0.23	0.24	0.95	0.34
Income	0.22	0.11	1.99	0.05
Occup	0.16	0.093	1.73	0.08
Gender	0.30	0.36	0.84	0.40
Study	0.72	0.21	3.49	0.00
Year	−0.02	0.01	−1.35	0.18

Discussion and Conclusion

In this paper, CVM was used to estimate the monetary value of karst caves. Scientific research has been mainly involved in studying the caves mainly from the environmental, archeological, and geological perspectives, while only few studies have dealt with analyzing the socio-economic and managerial aspects, especially with reference to monetary evaluation of karst caves. To fill this lack in the literature, this study aimed to investigate the monetary evaluation deriving from tourists' fruition of karstic caves.

The analysis was carried out taking into consideration a sample site located in the Italian territory, the Green Caves of Pradis. The experimental design used in this case included face-to-face interviews submitted to 540 visitors. The open-ended estimation was employed to elicit WTP, giving the respondents the opportunity to answer by stating the maximum amount they were willing to pay. On the basis of these data the Gross Social Benefits produced by caves have been quantified, which was about € 23 thousand per year.

Our findings demonstrate that tourists were willing to pay for the use of karst caves and their conservation, which is in line with existing literature (Susilowati et al. 2018; Aynon et al 2015; Araujo et al. 2015; Khodaverdizadeh et al. 2011; Tapsuwan et al. 2010). Our results showed that although there was some preference heterogeneity, a number of individual characteristics (e.g., educational level, income, and occupational position) were significant in explaining the availability to contribute to enhance tourism activities in the area of Pradis caves, according to the literature (Aynon 2015; Khodaverdizadeh et al. 2011). The same result is also obtained in the case of complex sites where the caves are included in the visit activities and are part of the various amenities (Leng and Lei 2011; Samdin et al 2010; Samdin 2008).

This evaluation can pave the way for more balanced and powerful support in decision making regarding sustainable tourism and policy-making with the provision of specific financial resources. Moreover, it gives the opportunity to compare costs and benefits. Consequently, it would be possible to reduce tourism activities with negative effects on sustainability, while increasing those with positive effects.

Table 6 Gross social benefits by type of entrance fee

Type of entrance fee	Net benefit (€/trip)	%	Visits (2010–2014 average)	Gross social benefit 1	Visits (2016)	Gross social benefit 2
Free	5.65	9.0	810	€ 4576.50	1350	€ 7627.50
Reduced	2.50	25.0	2,250	€ 5625.00	3750	€ 9375.00
Full	2.16	66.0	5940	€ 12,819.70	9900	€ 21,366.17
Total		100.0%	9000	€ 23,021.20	15,000	€ 38,368.67

The economic valuation of benefits of karst caves supports decision makers in giving a value to karst caves benefits. Consequently, it could be possible to avoid deterioration of such areas and the adoption of unsustainable tourism activities due to comparison between these benefits and cost of conservation.

Any expansion in the number of visitors must certainly be related to the carrying capacity of the caves itself, analyzing the various elements of risk associated with the resilience capacity of the ecosystem (Arrow et al. 1995; Ilioupoulou-Gerogudaki and Skuras 1995; McCool and Lime 2001; Russel et al. 2008; Benedetto and Carboni 2017; Šebela et al. 2019; Pachrova et al. 2020). For this reason, it is extremely important to measure and analyze the tourist flow/monitoring ratio of internal parameters in order to verify both the current and potential conditions that can be increased up to the limit beyond which the system can no longer consider it in balance.

The use of tourist carrying capacity involves two important results: on the one hand, it aims to preserve the environment and ensure its resilience, and on the other to guarantee the quality of the visit (Chen et al. 2021; Butler 2017).

Given the still very low current usage of monetary valuation of environmental benefits in decision-making processes, it seems clear that the use of our findings has improved local institutional decision-making. Environmental benefits are often not considered on an equal footing with costs when decisions about tourism are made, while the above described results were used by local institutions to lead to more valuable environmental outcomes, through better cost–benefit comparison of their decision regarding tourism activities linked to Pradis caves.

Even though our research represented an attempt to evaluate the WTP for the use and conservation of karst caves and the results were effectively used by local institutional decision makers, it does have a number of limits and needs for future works. Regarding the application of the CVM, the realization of repeated annual surveys could help track possible variations in the WTP, interpret them using other explanatory factors, such as the nationality of visitors, and measure how the economic value of the cave varies over time. Furthermore, as an alternative to the global approach of CVM, other methodologies, such as the Choice Experiment, may help evaluate individual attributes of the karst caves, helping to understand the path of choice made by an individual and the identification of the most preferred alternative (Hanley et al. 2002).

Within the limits of this study, the results make several contributions to the knowledge of possible investigation on caves, taking up the invitation made in literature (Prijateli and Skeates 2018), by demonstrating a possible application of the CVM as well as proposing possible further implementations. Our findings supported local institutional decision-makers and enhanced the development and management of tourism in karstic caves, since they needed to know tourists' WTP to check entrance fees (Samdin et al 2010; Samdin 2008) and monitor the quality of both tourism activities and environmental conservation. Furthermore, given the scarcity of studies on the economic monetary value of karst caves, the straightforward research scheme and the simple analytical tool adopted can certainly be re-proposed for the analysis of other karst caves. The results seem to be relevant also to gaining a better understanding of how sustainable tourisms can help in the attainment of the SDGs and how policy decision makers can prioritize resources to restore and maintain iconic habitats (SDGs 14,15), heritage, and cultural identity (SDGs 10, 11), and promote a more sustainable tourism industry (SDGs 8, 10).

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Declarations

Competing Interest The authors declare no competing interests.

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